The Aging Voice

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Prevalence & Age of Onset

- Benninger: 12% of elderly have significant voice problems
- Stemple, Glaze, & Klaben (2000): Presbylaryngis begins around 65 years old.
Introduction

- Listeners can estimate the age of a person from the perceptual quality of their voice.
- Breathier, decreased volume, relative higher pitch, diminished flexibility and increased tremulousness
However,

- Woo, 1992: 151 dysphonic patients over the age of 60, only 6 related to aging
- Voice changes in the elderly: more likely to be influenced by disease rather than by physiologic aging
Aged vocal folds

**FIGURE 1.** Vocal folds bowing and prominence of vocal processes during inhalation.

**FIGURE 2.** Spindle-shaped glotic chink.
Decrease in breath support.

- Weakening of respiratory muscles
- Decrease in pulmonary function (increase emphysema)
- Decreased elasticity
- Increased parenchymal stiffness
- Vital capacity decreases and residual volume increases. Maximum expiratory flow rate is decreased and lung pressure is decreased
- Weakened voice, more frequent breaths
- Try to compensate by contracting the vocal folds\(\rightarrow\) may result in a strained vocal quality (muscular tension dysphonia)
Cricoarytenoid joint

Mark fibrillation of the superficial cartilage
Chondrocyte cluster near the joint surface
mechanically caused arthrosis

Smooth articular surface shows degenerative change

Sagittal section through the joint surface (88 y/o male)

Scanning electron microscopic photograph of the articular facet of a cricoid cartilage
Cricoarytenoid joint

Shows fibrillation

High immunoreactivity in the fibrillated superficial cartilage layer and around chondrocyte cluster, deeper cartilage layers do not bind to the antibody.

Scanning electron microscopic photograph of the articular facet of a an arytenoid cartilage (77 y/o male).

Immunohistochemical proof of type III collagen (don’t usually occur in adult joint cartilage).
Cricoarytenoid joint

- Impair gross positional or postural movements (smoothness) of the arytenoid cartilage
- Reduce the degree and extent of vocal ligament closure
- Impaired vocal quality and reduced vocal intensity (air leakage)
The Vocal Folds

- Three layered lamina propria
  - Superficial Layer *(Reinke’s space)*
  - Intermediate layer
  - Deep layer
    - the intermediate and deep layers make up the vocal ligament

- Vocalis and thyroarytenoid muscle
Vocal fold

Extracellular matrices in superficial layer of lamina propria

A) Younger adult  B) aged adult

Reticular fibers - key components of the structural maintenance and viscoelasticity, most abundantly around the vocal fold edge, thin and more compliant tissue,

Elastic fibers - elasticity and resilience to the tissue, intermediate layer

Collagenous fibers - great resistance, deep layer
Laminae propriae of older adult

Collagenous fibers formed bundles and their density was high

The collagenous fibril diameters differed (40 to 80 nm), twisted
Vocal fold of aged adult

Silver stain-collagenous fiber are increased in lamina propria

No layered structure
Vocal fold of aged adult

- Collagenous fibers had increased, formed bundles, density was high
- Extracellular matrices & reticular fibers had decreased
- Collagenous fibers diameters differed, outline was irregular, twisted
- Masses of dense collagenous fibers
- No layer structure
Laryngeal Changes

- Ossification and calcification of laryngeal cartilages
- Atrophy and degeneration of intrinsic muscles
Increased calcification & muscle atrophy

A-arytenoid
C-cricoid
a-Articular surface
S-synovium
P-periarticular soft tissue
fat arrow-
hypopharyngeal epi
thin arrow- subglottic respiratory epi
(HE X3)
Laryngeal changes

- Baker, Ramig, Sapir (2001): studied old and young adults’ ability to regulate loudness.
- Measured laryngeal electromyographic amplitudes of the thyroarytenoid, lateral cricoarytenoid, and cricothyroid muscles.
- The older adults had a weaker and less efficient adductor system → reduce ability to produce loudness when needed in some speaking situations.
Laryngeal Changes

- Degeneration of glands in the laryngeal mucosa: drying of epithelium, increase stiffness of VC cover → increase instability of vocal fold vibration and raise fundamental frequency (F0)
- Nerve: decrease in myelination and the number of neuromuscular junction in the intrinsic laryngeal muscle
- Ximenes (2003): reduction of the lamina propria thickness and of epithelial cell: inability to get complete glottal closure; gap in the middle third of the vocal folds (bowing of the vocal folds) → most common benign pathology of the aging voice, more evident in man
## Aging in the Larynx

<table>
<thead>
<tr>
<th>Laryngeal Structure</th>
<th>Nature of Aging Change</th>
<th>Gender Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cartilages</td>
<td>Ossification &amp; calcification</td>
<td>More extensive, earlier onset in males</td>
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<tr>
<td>Cricoarytenoid joint</td>
<td>General deterioration</td>
<td>More evident in males</td>
</tr>
<tr>
<td>Intrinsic muscles</td>
<td>Atrophy</td>
<td>In males; limited data in females</td>
</tr>
<tr>
<td>Epithelium</td>
<td>Thickening</td>
<td>Progressive in males until 70, declines thereafter. Progressive in females after 70</td>
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</tbody>
</table>

From Linville, Vocal Aging
Supralaryngeal system

- Altered resonance patterns: growth of the craniofacial skeleton, lowering of the larynx in the neck, degenerative changes in oral structures that reduce articulatory precision
- Degenerative changes in the temporomandibular joint, thinning/loss of elasticity of oral mucosa
- Declining salivary function
- Loss of tongue strength, tooth loss
- Dentures may cause a loss or change of some proprioceptive feedback
Gender Changes - women

- F0 remains fairly constant until menopause, when a drop occurs (approximately 10 Hz - 15 Hz).
- This drop presumably results from hormonal changes → thickening and edema of the laryngeal mucosa, increased vibratory mass, so decreased pitch.
- From ~220 Hz in young adulthood to ~190-200 Hz in older adulthood.
Gender Changes - Men

- F0 lowers approximately 10 Hz from young adulthood to middle age. The reason is unclear.
- After middle age, F0 in men rises substantially (approximately 35 Hz) into advanced old age, reaching the highest level of adulthood, vocal folds become thinner and atrophied; increased pitch
- From ~125 Hz in young adulthood to ~145-150 Hz in older adulthood
Pitch versus age

Speaking fundamental frequency ($SF_0$)
Max. phonation frequency range
Tremor or instability

- Tremor have been associated with the aged voice.
- Jitter (cycle to cycle frequency variation) and shimmer (amplitude variation) increases with age.
- These voice characteristics may result from F0 or amplitude instability.
- Stability of F0 reportedly declines from young adulthood to old age in both men and women.
Unsuccessful compensatory voice use

- Male
  - Attempts to drop pitch
  - Gravelly, breathy, glottal fry
  - Easily fatigue
  - Apparently bowed vocal

- Female
  - Attempts to raise pitch
  - Squeezed, strained
  - Effortful voice
  - Variable ventricular band adduction
Treatment of aging voice

- Avoidance of compensatory maneuvers
- Women strain to increase vocal pitch which can result in hyperadduction of the false vocal folds
- Men may attempt to lower pitch resulting in a gravelly, breathy voice that is easily fatigued
- Thus prevention of compensatory functional misuse is important
- Men may gradually adjust their vocal pitch upwards, women attempt to relax their laryngeal muscles
Treatment of aging voice

- Voice therapy: singing exercises to strengthen the laryngeal muscle and improve the technique of voice production
- Breathing technique and vocal hygiene
- Adequate hydration & humidification: improve lubrication
- Exercise: swimming (deep breath)
- Avoid laryngeal irritants
Injection (lipid or silicon): lower the pitch and closing the glottic gap

**Table 1: Brighton and Worthing Voice clinic protocol for the management of bowed vocal folds**

<table>
<thead>
<tr>
<th>Phonatory gap</th>
<th>&lt;1mm</th>
<th>1 – 2mm</th>
<th>&gt;2 mm</th>
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<tbody>
<tr>
<td>Treatment</td>
<td>Voice Therapy</td>
<td>Bilateral injections</td>
<td>Bilateral Thyroplasties</td>
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</table>


